Cometary Atmospheres: Modeling the Spatial Distribution of Observed Neutral Radicals

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16. Abstract

The analysis of observed brightness profiles for the C_2 radical in comets with Haser's model implies that the parent scale length varies as the square of the heliocentric distance. The use of new Haser scale lengths for C_2 and CN determined under this project appears to explain the apparent drop in the C_2-to-CN ratio with increasing heliocentric distance.

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I. Program of Research for the First Quarter

Research activities during this first quarter have involved (1) meeting with Dr. Uwe Fink of the University of Arizona with whom a collaboration has begun in order to analyze observations of the spatial distributions of neutral gases and (2) a preliminary draft of a paper on the observed distributions of the C_2 radical in comets.

1. Model Analysis of New Observations

A collaboration with Dr. Uwe Fink of the University of Arizona had been initiated during the third quarter of the previous project year in which we would analyze the spatial distributions of neutral gases as observed in Dr. Fink's program of CCD long-slit spectrophotometry and narrow-band imaging of comets. During a visit I made to Tucson this past quarter, in addition to my presenting a colloquium on modeling the neutral coma, we previewed raw CCD filtered images and spectra of Comet P/Giacobini-Zinner taken the previous month by Dr. Fink at the 61-inch telescope at Catalina Mountain. Images in the band containing CN emission were clearly distinctive from nearby continuum images, and a likely detection of an [OI] image at 6300 Å was also found.

2. The Distribution and Production of Cometary C_2

A preliminary draft of a paper which deals with the production and observed distribution of C_2 in comets is in preparation. The paper reports new observational data which had been reduced prior to the start of this project. These data are being re-analyzed and combined with other newly-available data in the literature under this project. This work has involved an ongoing collaboration with Dr. A.H. Delsemme of the University of Toledo. The results of this work will also be presented at the Division of Planetary Sciences meeting in Baltimore on October 29, 1985.

The principal results of the paper are (1) new Haser model scale length dependencies on heliocentric distance (see Figures 1 and 2), (2) specification of the parent and C_2 lifetimes, and parent and C_2 ejection velocities determined using the radiation pressure distorted profiles and the Monte Carlo particle-trajectory model, and (3) a resolution of the previously asserted drop of C_2 production in comets relative to other species ($r > 1.2$ AU), which is only an artifact of an incorrect parent scale length law (see Figure 3).

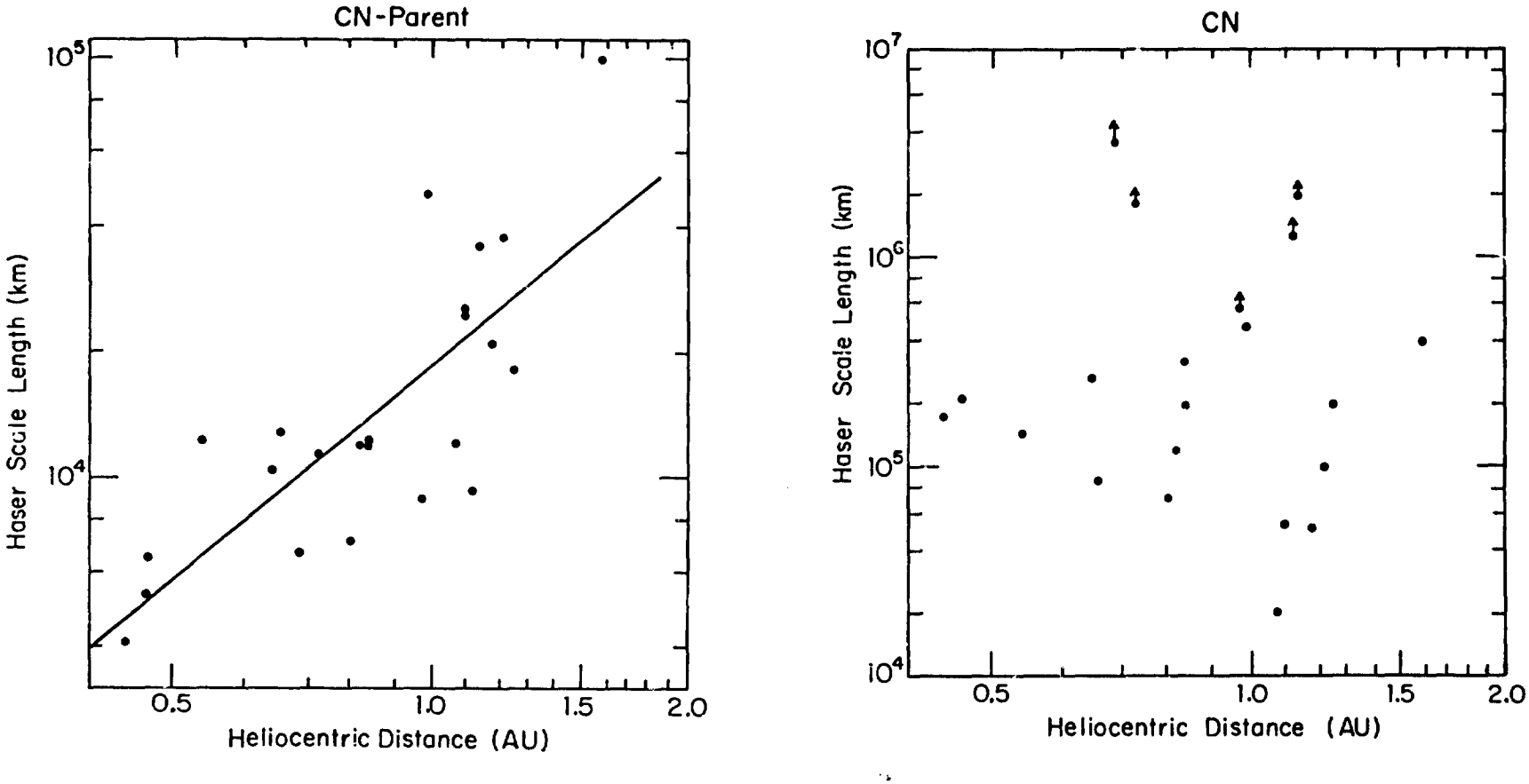

Figure 1. Haser Model Scale Lengths for CN.

The Haser model parent (a) and daughter (b) sclae lengths fitted to full observed brightness profiles are plotted as a function of heliocentric distance. In (a) an $r^{1.44}$ law is the best fit to the data and is consistent with the $r^{1.5}$ which would be expected from photodissociation and an $r^{-0.5}$ velocity law. In (b) no observable trend is seen. Data were from Combi (1978), Combi and Delsemme (1980), Cochran (1982), Delsemme and Combi (1983), Johnson et al. (1984).

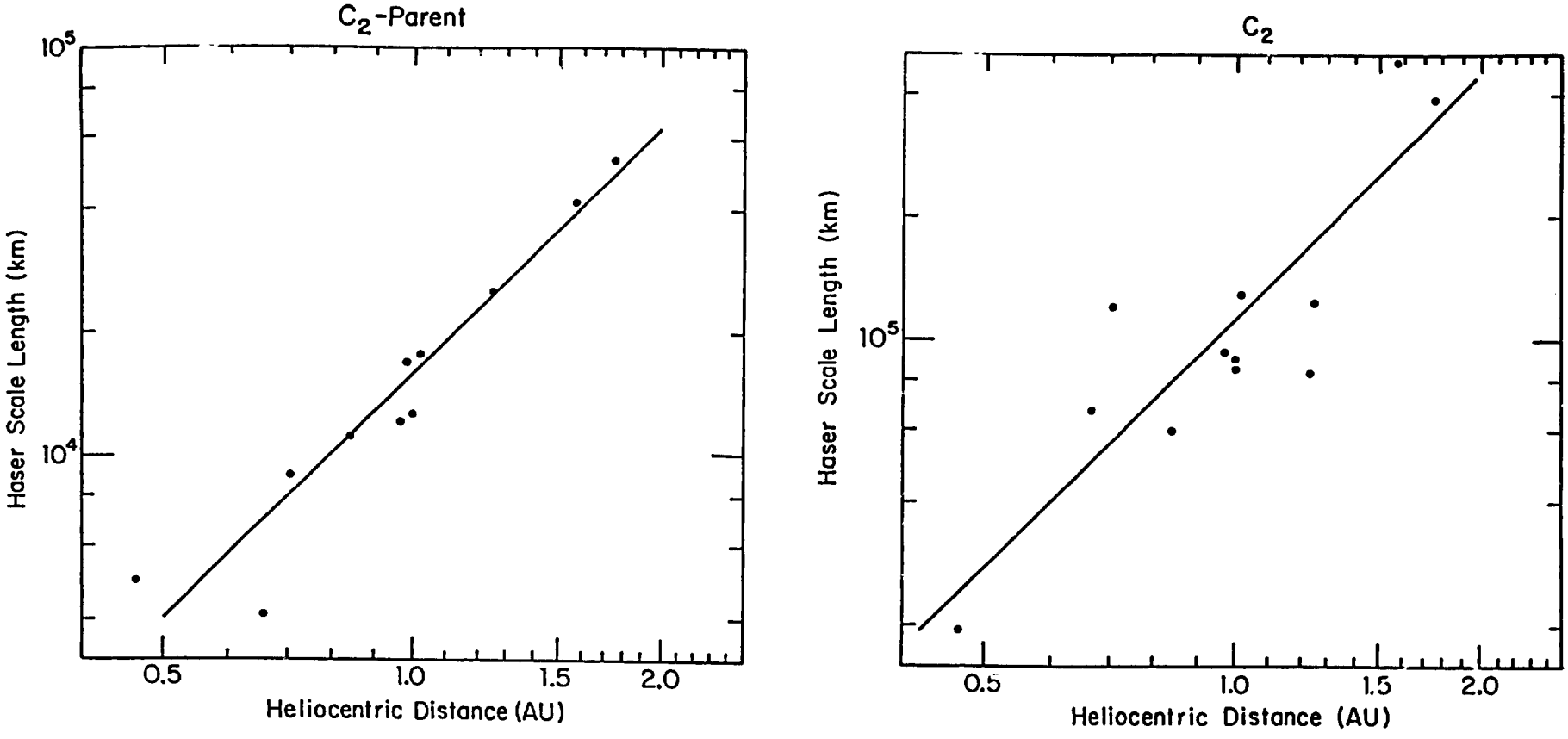

Figure 2. Haser Model Scale Lengths for C_2.

The Haser model parent (a) and daughter (b) scale lengths fitted to full observed brightness profiles are plotted as a function of heliocentric distance. An $r^{2.0}$ law is the best fit to both sets of scale lengths. The r^2 law for the C_2 parent may mean that the C_2 parent may infact be a daughter radical. Data are a combination of new data with those from O'Dell and Osterbrock (1962), Delsemme and Miller (1971), Kumar and Southal (1976), Combi (1978), and Cochran (1985).

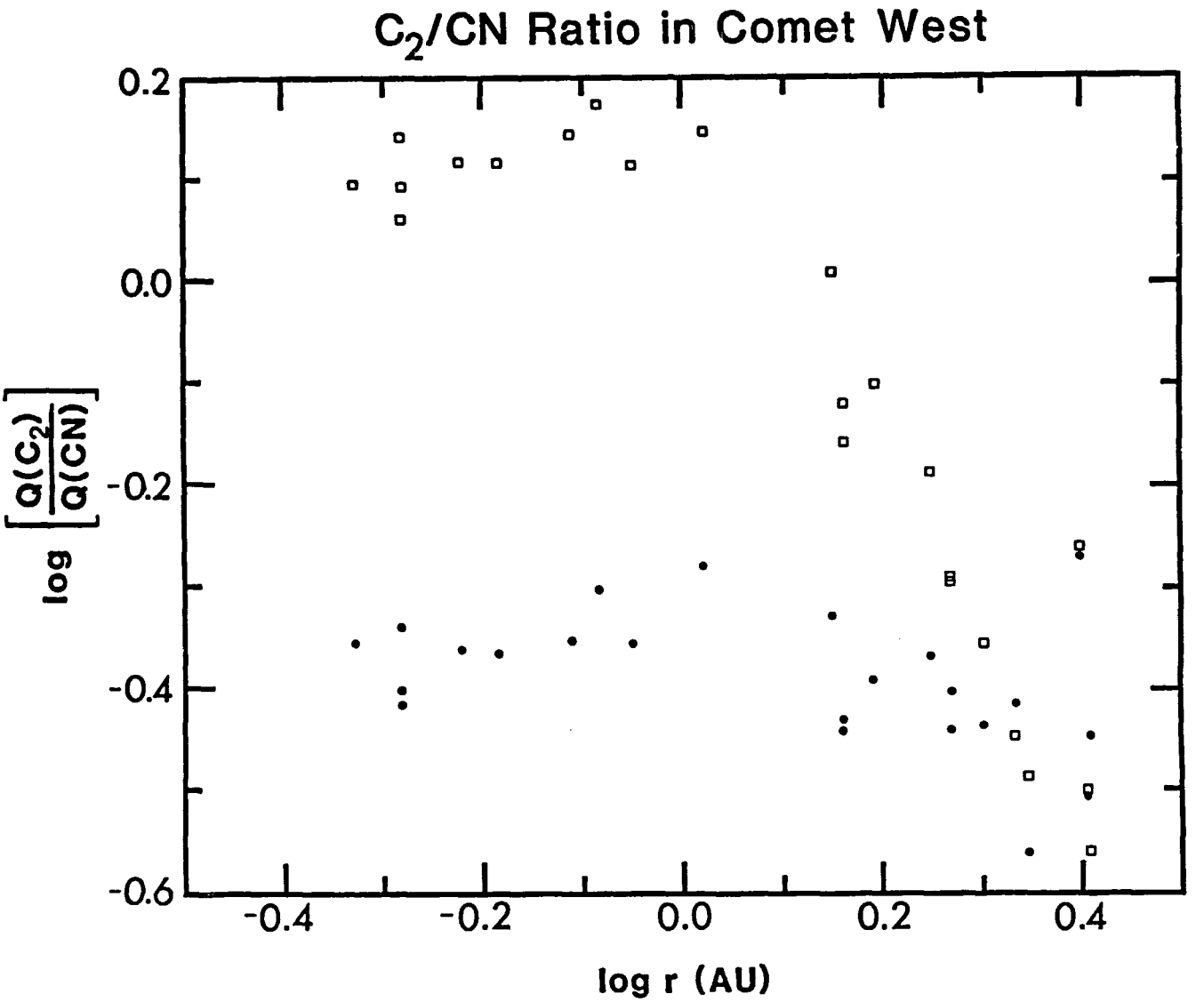

Figure 3. The Relative Productions of C_2 and CN in Comet West (1976VI)

The photometry of A'Hearn, Thurber and Millis (1977) is shown as reduced with the Haser model scale length laws assumed by A'Hearn and Cowan (1980) [□] and with the new values found by us [•]. A'Hearn and Cowan used an r^2 law for CN, CN-parent and C_2, and an r^1 law for the C_2 parent. When we use $r^{1.5}$ for the CN-parent and r^2 for the C_2 parent, the anomalous drop in C_2 production for $r > 1.2$ AU disappears.

II. Program of Research for the Second Quarter

Research activities for the second quarter will concentrate on completion of the C_2 paper with Armand Delsemme and evaluation of the observed C_3 and OH distributions in comets.

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